Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

Task Force Members in Attendance:	Ross Gittell, Chairman; Brian Blake; Barbara Couch; Susan D'Agostino; Mary Kate Hartwell, Joseph Helble; Caroline Herold; Robert Hallowell; Todd Lamarque and Paul Leather
Unable to Attend:	Joyce Craig, Jeremy Hitchcock; Dean Kamen; Palligarnai Vasudevan.
Others present:	Molly Connors, Governor's representative; Mary Laturnau, Director of School Engagement, Project Lead the Way; and Michele L. Munson, Ed.D., Educational Program Consultant, NH EPSCor-STEM NH

I. Call to order

Chairman Gittell opened the meeting at 4:00 p.m. by welcoming members of the Task Force and the public who were present at the meeting.

II. Approval of August 25, 2014 minutes

Robert Hallowell made a motion to accept the minutes. Dr. Susan D'Agostino seconded. The minutes were approved unanimously.

III. Items requiring discussion

a. Overview for next phase of the Task Force recommendations development. Chairman Gittell reviewed the work plan and timeline with Task Force, noting that the Governor would be asked to preview recommendations before proceeding to the final report. The Taskforce will be notified when the date is scheduled. (Addendum One: Work Plan/Timeline and Draft Summary of Eight Recommendations)

b. Presentation and review of four recommendations (Addendum Two). Task Force Groups presented their work in progress and received feedback from other Task Force members as followed:

Group 2: Early College Academies: Clarify the proposed governance structure (Board of Directors) for the Early College Math/Science Academy and the Career/Technical Education Academy , and clarify the intended goal "big picture purpose" of the Early College Academies (why the need for two Early College Academy models?)

Group 5: Career Pathways Planning: Clarify the meaning of career "exploration" in elementary and middle school years. How does this differ from career explorations in 7-9th grades? Task Force suggested Group 5 consider various delivery models such as "road shows" and career day

fairs where different STEM occupations could be showcased; suggested need to link benchmarks more closely to recommended actions.

Group 7: Mathematics Curricula Pathways: Address the key actors needed to support implementation of expanded math curricula pathways, particularly the introduction of new courses in coding and data analysis. Should coding be accepted as a substitute for other math courses? What "foundational" math is essential and what math courses may be substituted? Prepare benchmarks and timelines for this recommendation.

Group 6: Teacher Prep and Prof Development: Clarify more specifically how connections in referenced reports (the National Council on Teacher Quality, NH Charitable Foundation and New Hampshire State Task Force on Mathematics Instruction) might apply to teacher preparation in STEM fields. Is the lack of STEM preparation concentrated in early grades (K-6) or a consistent problem throughout K-8? K-12? How might STEM knowledge gained in non-traditional pathways (such as independent study, workshops, etc.) be recognized through badges or micro-credentials? Say more about alternative certifications for mid and late career professionals who have worked in STEM careers.

IV. Public input:

Mary Laturnau briefly explained the purpose of Project Lead the Way and distributed information; Dr. Michele Munson noted that NH EPSCoR-STEM NH would be happy to discuss and offer input on the Task Force's recommendations when appropriate.

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

ADDENDUM ONE

GOVERNOR'S TASK FORCE ON STEM EDUCATION WORKPLAN AND TIMELINE

Overview:

This next phase of work moves us from early stage recommendations through to a final draft for the Governor's preliminary review prior to writing the final report. We now move to new small groups to address each of the 8 recommendations which emerged from the August 13, 2014 meeting (as a result of combining similar recommendations)[1]

Each group has a lead author to guide and facilitate the next phase of work. See *Task Force Round 2 Recommendations and Group Assignments (attached)*

We have prepared the following to guide your efforts. We welcome your suggestions for improving this.

ELEMENTS TO INCLUDE:

As we go forward, here is a suggested format for your final recommendations.

- Recommended actions, benchmarks and timelines (see example from MD Task Force excerpt attached)
- List actors, expectations and roles they will need to play. Consider: teachers, students, parents, administrators in K-12; school boards, post-secondary educators and administrators, the NH legislature, business/industry, professional and nonprofit organizations and the NH general public
- Revised or reaffirmed items from the initial recommendation such as (a) problem statement (b) goals (c) success metrics, (c) challenges (d) opportunities
- Other factors that you think should be considered when reviewing the recommendation

TIMELINE AND MEETING SCHEDULE

August 25	4-6 pm MCC Room 272 – new groups meet to plan work and assignments
September 16	Groups exchange work prior to meeting and discuss at meeting; everything covered?
September 25	Draft recommendations are reviewed for comments and revisions
October 7	Final review prior to presenting to Governor for preliminary review for questions, clarifications

[1] The recommendation to create a NGSS/STEM coordinator in the Department of Education was tabled pending development of the other recommendations.

	and suggestions
October 14	Review and discussion of report outline (distributed prior to meeting); additional writing assignments (volunteer)
October 21	Report draft reviewed and revisions suggested; professional editing and proofing Completed before next review
October 30	Optional: reserved in case above schedule is delayed or additional review needed
November 4	Final report reviewed and approved
November 10	Reserved if needed for unexpected delays
November 14	Report is submitted to the Governor

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

ADDENDUM ONE (Continued)

DRAFT SUMMARY OF EIGHT RECOMMENDATIONS (prepared Sep 16, 2014)

I. ***STEM Foundation Disciplines:***

Group 7: Math Curricula Pathways: Choices for STEM Success RECOMMEDATION: Expand options for fulfilling 4-year math requirements. In addition to traditional math studies (including calculus), suggests adding option to fulfill requirements with data and statistical analysis courses suited for a wide variety of STEM-related careers. In addition, suggests adding "coding" courses which are not only in high demand in NH industry but also teach basic critical thinking skills. Follows the practices in some other STEM-leading states adopting coding as basic math and science course requirement.

Group 8: Next Generation Science: Hands-on Learning for 21 Century Skills. RECOMMENDATION. NH should adopt Next Generation Science Standards. NGSS integrates 21st learning skills such as project and real-world problem based learning and teaches STEM (especially science, engineering and technology exposure) while integrating with K-12 math and English Language Arts requirements. This recommendation is central to others by the Task Force.

II. ***Inspiring Students:***

Group 1**: STEM-INSPIRATION: STEM Discovery and Collaborative Competition (Invention?) in NH's Schools.** RECOMMENDATION: Applied STEM learning opportunities, including competitions, should be expanded and incorporated into curriculum using FIRST as a base and model program. Age-appropriate STEM-INSPIRATION sequencing should begin with thematic, problem- and project based STEM topics in early grades, then moving to collaborative, team-based district-wide STEM competitions in middle school, and finally to a capstone project which requires independent problem-based project research, and presentation of results for peer and evaluator review in high school. NGSS (adopted by many districts in NH) is closely aligned and integrated into this work, as well as engineering and technology curricula.

Group 2: NH STEM Early College Academies of Excellence. RECOMMENDATION: Establish STEM advanced studies leading to high school diploma and 1- or 2-years of college credit through combination of classroom and real-world research and career experience in a two-pronged approach. First option offers students while still in NH High Schools opportunities for STEM scientific studies including working on actual projects with academic and industry scientists. The second option reformulates NH CTE schools into Early College Career Academies, offering students advanced STEM applied studies and industry work experience, while also gaining college credits. The Academies would also provide statewide outreach for STEM education into K-12 classes, afterschool, and special activities (modeled on the outreach of St. Paul's, Concord, NH).

Group 5: STEM Personal Learning Plans: Pathways to Career Success RECOMMENDATION: An early understanding of what is required to be "STEM educated" and on a pathway to desired career in STEM or other field can be highly beneficial to students and their families and advancing STEM education in NH. To support this all NH students starting in grade 7 should be able to develop Personal Learning Paths which include interest inventories, career information, course advising support, job shadowing experiences and a written plan. Having a PLP should be made a requirement for all students to have by their first semester of high school and to be updated in their junior year. PLPs can act as "connectors" between STEM/Career exposure (see Group 1 and 4), and high school STEM and CTE studies.

III. ***Supporting Teachers***

Group 3: STEM Teacher Support Network: Utilizes existing regional STEM Centers in NH to provide STEM professional development in STEM content and teaching practices for teachers through short courses, workshops and a shared digital STEM education resources "commons." This recommendation seeks to create a professional learning community by connecting STEM teachers and administrators with STEM business/industry practitioners and scientists (real world problem-solving).

Group 4: STEM Every Day in Different Ways in K-8 Education: Curriculum Integration in the Classroom: RECOMMENDATION: Support the "day to day" application of science and math in pre-high school education. Goal should be applied STEM every day in different ways for young NH learners. This would involve applying math and core sciences using technology and engineering principles and concepts in classroom instruction and team school projects. The technology and engineering is the "TiE" that makes STEM relevant and exciting particularly for the younger students especially those who are not inclined to learn math and science as theory or by rote. This recommendation attempts to address two key barriers to STEM education -- the tightly packed K-8 schedule and the lack of current and applied science expertise among teachers in K-8 grades. This recommendation seeks to help teachers to integrate STEM topics and practices into current math and English language arts requirements. It also is meant to aid STEM teaching professional development with a "STEM master" teacher/mentor in each school or district who can help to organize STEM applied activities.

Group 6: STEM Teacher Preparation and Professional Development: Learning through Real World Problem Solving RECOMMEDATION: Puts forward plan to support and reformulate STEM teacher preparation requirements and to institute STEM certificates, endorsements and micro-credentials to speed training of STEM-qualified teachers. This recommendation attempts to respond to recognized problem of too few science and STEM-qualified teachers, especially at K-6 (who are generalists, often without sufficient math and science training).

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

ADDENDUM TWO

Group 2
DRAFT: STEM EARLY COLLEGE ACADEMIES (Revised 9.16.14)
World-class education for NH students

TOPIC	DESCRIPTION FRAMEWORK
Problem statement *What problem are you addressing?*	Young athletes look to professional sports to motivate their pursuit of athletics but ambitious young STEM students in New Hampshire do not have an aspirational vision to motivate their academic and career pursuits. One consequence is that many high school graduates are inadequately prepared for careers or higher education in STEM fields. In addition, NH businesses, businesses interested in relocating to NH, as well as New Hampshire's public and private universities have expressed grave concern about the NH STEM pipeline. NH's low production of graduates unprepared for STEM careers and higher education is a significant disadvantage when it comes to participating in the STEM economy, an employment sector that is growing at a faster rate and pays higher-than-average wages than the non-STEM employment sector.
Target Audience?	K-12
% of target audience you will reach? 25% 50% 75% 100%	Indirect targeting: 100% of K-12 students will be targeted indirectly as the STEM Early College Academies are intended to provide an aspirational goal in the minds of all young people in NH. Direct targeting: • 50% of 6-8 students will be targeted for participation in extracurricular, co-curricular, and summer programs in STEM. • 50% of 9-12 students will be targeted for participation in extracurricular, co-curricular, and summer programs, and through enrollment in STEM degree and certificate programs.
What are your desired goals or outcomes? *Describe how the outcomes or goals will positively impact the problem addressed*	The STEM Early College Academies will serve as the face and the engine of STEM academic and career aspirations for young New Hampshire citizens and their families. In addition, New Hampshire businesses, businesses interested in relocating to New Hampshire, and New Hampshire's public and private universities will gain confidence that New Hampshire is home to a critical mass of STEM graduates who are prepared for success in STEM careers and higher education. Finally, the STEM Early College Academies will advance public 6-12 STEM education in New Hampshire through offering STEM enrichment programs for students, professional development for teachers, and educational enrichment programming for schools.
What is your recommendation/s (big idea/s) *Describe the recommendation. How does this recommendation achieve*	Funded by both the State of NH as well as the private sector, the STEM Early College Academies will embody two organizations: • The New Hampshire Math and Science Academy (NHMSA) – a new, free, public, residential, college preparatory high school for 400 academically talented juniors and seniors interested in pursuing a specialized curriculum emphasizing STEM subjects. Modeled after the North Carolina School of Math and Science, NHMSA students will earn a high school degree as well as skills and competencies that set them up for success in rigorous undergraduate and graduate STEM degree programs. The purpose

outcomes/goals to meet the needs of your target audience?	of the NHMSA will be to educate gifted and talented NH STEM students as well as to provide outreach programs in STEM to students, teachers, and schools around the state. The school's admission policy, curriculum, and outreach division shall reflect these goals. While the NHMSA will offer an extensive STEM curriculum that goes beyond what most public high schools offer—including classes for credit at both the secondary and post-secondary level—it will also provide a solid foundation in the arts and humanities that would be expected of any high school graduate preparing for entrance into a highly competitive college. Though new buildings may be to be built, the NH Legislature should provide substantial incentives as they solicit proposals from NH's residential educational institutions—including UNH, Dartmouth, SNHU, or Philips Exeter Academy—or other appropriate organizations or agencies for hosting the NHMSA for a minimum of twenty years. This way, the school would benefit from a comprehensive campus that already includes laboratories, library facilities, student centers, or other infrastructure necessary for the proper operation of a residential school. The NHMSA will be funded by the State of NH as well as public and private grants or donations made in support of the school. Though the NHMSA will enroll high school students, it will be governed by the NH public university system as well as a Board of Directors that includes a diverse group of NH STEM stakeholders from education and business. • The New Hampshire Career and Technical Education Early College Academies (NH-CTE-ECA) – a collection of free, public, transformed CTE schools throughout the state for talented students interested in STEM-focused programs that integrate academics with career preparation. NH-CTE-ECA students will earn a high school degree, a certificate or 2-year applied science degree, as well as the skills and competencies that set them up for success in well-paying, high-potential STEM jobs. Each NH-CTE-ECA will be a partnership between a NH public high school, the NH community college system, and NH STEM businesses. The purpose of the NH-CTE-ECAs will be to educate high-potential, career-oriented NH STEM students as well as to provide outreach programs in STEM to students, teachers, and schools around the state. The schools' admission policy, curriculum, and outreach division shall reflect these goals. The NH-CTE-ECAs will be transformed versions of our current CTEs. The transformation will include, but not be limited to, 1.) full time enrollment for students in grades ten, eleven, and twelve 2.) math and science instruction will take place on site so that students will no longer be required to commute to and from the sending high school 3.) a required, semester-long internship in a high growth STEM field in the final year of the program 4.) a minimum 12 earned college credits for all graduates—with the option of pursuing a certificate or associate of science degree—during the high school years, at no cost to the student 5.) community mentors from high growth STEM fields for all enrolled students from the point of enrollment. The NH-CTE-ECAs will be funded by the State of NH as well as public and private grants or donations made in support of the school. The NH-CTE-ECAs will be governed by the Department of Education as well as a Board of Directors that includes a diverse group of NH STEM stakeholders from education and business. In addition, the STEM Early College Academies will offer extracurricular, co-curricular, and summer outreach programs to K-12 students throughout the state, as well as professional

	development programs for STEM teachers (both on site at the NHMSA or the NH-CTE-ECAs as well as on location at elementary, middle, and high schools throughout the state). Outreach programs will be modest in grades K-5 but more robust in grades 6-8 and 9-10 to coincide with recruitment efforts for the degree programs offered at the NHMSA and the NH-CTE-ECAs.
What constitutes "success" for this idea if implemented? *What data is needed? What are the targets and milestones to monitor progress?*	Data concerning participation and graduation will be collected as soon as the STEM Early College Academies are established. The targets are: • 100% of NHMSA graduates proceed to college, the majority in STEM fields • 100% of NH-CTE-ECA graduates acquire well-paying, high-potential STEM jobs • 50% of 6-8 students will participate in extracurricular, co-curricular, or summer programs designed by a NH School of Excellence • 50% of 9-12 students will participate in extracurricular, co-curricular, summer programs, or certificate and degree programs designed by a NH School of Excellence. • Graduates of a STEM Early College Academy serve as local, state, national, and global leaders in STEM fields, maintaining ties to the ten NH counties from which they hailed. • The names, "New Hampshire Math and Science Academy" and "New Hampshire CTE Early College Academies" become synonymous with STEM ambition and success in New Hampshire and beyond.
Implementation plan: if this idea is implemented, what is needed to make it successful? *Who are the actors? What do they need to do?*	Note: Timeline and actors are underlined November 2014: The Governor will appoint a committee of STEM stakeholders to draft a bill that may be presented to the legislature in order to establish the NH Early College Academies (including both the NHMSA and the NH-CTE-ECAs). November 2014 - May 2015: The Governor's appointed committee of STEM stakeholders will draft a bill that includes precise details concerning the purpose, curriculum, governance, public and private funding, structure, budget, operation, target dates, and required staff, faculty and administrators of the NH Early College Academies. Regarding the NHMSA, the bill should also detail a plan for publishing a 'request for proposals' to solicit proposals from NH educational institutions or other appropriate organizations for hosting the school. Regarding the NH-CTE-ECAs, the bill should detail a plan for publishing a 'request for proposals' to solicit proposals from existing NH CTEs for transforming into a NH-CTE-ECA or from existing public high schools interested in embedding a CTE-ECA on their campuses. The 'requests for proposals' for both the NHMSA and the NH-CTE-ECAs should include strong incentives for institutions interested in serving as hosts. Summer 2015: The NH Legislature passes the bill. Following, the Governor will appoint a Board of Directors for the NHMSA and a Board of Directors for the NH-CTE-ECAs. September 2015 – December 2015: The 'requests for proposals' mentioned above will be solicited, reviewed, and acted upon by the Board of Directors of the NHMSA and the Board of Directors of the NH-CTE-ECAs. January 2016 – December 2016: The Boards of Directors of NHMSA and the Board of

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

	Directors of the NH-CTE-ECAs oversee the building (in the case of NHMSA) or the transformation (in the case of the NH-CTE-ECAs). Administrators, faculty and staff will be hired. Students will be recruited. September 2017: The STEM Early College Academies open their doors.
Challenges?	This initiative will be costly and needs the support of the legislature and the private sector.
Resources needed?	Visionary educators and business people who may craft curriculum, outreach programs and internships. Human, financial, and capital resources from the state and business sector.
Timeline? Implemented with 1 yr? 2? 3-5 yrs?	Selecting a committee to draft the bill should begin immediately. Gaining approval by the legislature may take time but once that approval is secured, the schools could open with in one to two years (based on the experience of other states like NC and IL).
Examples of best practices/similar approaches in current practice in NH or elsewhere? **NOTE: Numerous additional examples will be provided upon request.**	Exemplary examples of free, residential, public, STEM-focused college prep high schools: • The North Carolina School of Math and Science, a vision of NC Gov. James Hunt Jr. • The Illinois Math and Science Academy, a vision of IL Governor Jim Thompson. • The National Consortium of Specialized Secondary Schools of Math, Science, and Technology represents 100 secondary. Similar to NCSMS and IMSA, many of their member schools opened within 1-2 years of their legislative mandates and have served as driving forces for STEM education and employment in their states. Exemplary examples of free, public, STEM-focused transformed CTE programs: • Pathways in Technology Early College High School (P-TECH) in Brooklyn, New York, a collaboration between the New York City Department of Education, the City University of New York, New York City College of Technology and IBM. • In Utah, every middle school student takes a year-long, exploratory Career and Technical Education (CTE) Introduction course that provides students with direction, decision-making, and planning activities to explore more than 60 CTE college and career pathways. Other examples include Wake Early College, a system that exemplifies CTE and Partnership for 21st Century Skills best practices and Project Lead the Way**,** a program implemented at many top CTE's for delivering STEM curriculum.

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

ADDENDUM TWO (continued)

Group 5
DRAFT: PATHWAYS: REVISED 9.16.14

TOPIC	DESCRIPTION FRAMEWORK
Problem statement *What problem are you addressing?*	Students have varied interests and may choose multiple paths, teachers have ample skills in how to teach students but sometimes limited knowledge of STEM subjects and careers, employers have good paying jobs available but struggle to find a skilled work force. Only one young person in three obtains a four-year degree by age 25—and roughly 30 percent of the job openings projected over the next decade requires some education beyond high school but not necessarily a four-year degree. (Pathways to Prosperity June 2014). We need to give more attention to building career pathways in high-growth, high-demand occupational fields that span high school and community or technical college preparation and beyond and can provide young people with skills and credentials valued in the labor market. NH can't afford *not* to come up with new approaches to career education and workforce development.
Target Audience?	Grades 6-12
% of target audience you will reach? 25% 50% 75% 100%	100%
What are your desired goals or outcomes? *Describe how the outcomes or goals will positively impact the problem addressed*	There will be comprehensive systems for (STEM) career information, advising, and exposure starting in middle school. Individualized learning plans (ILP's) are in place for students in grades 7 and 9. Students will have access to career exploration experiences in elementary and middle school years (drawing on the work of the iSTEM and C Cubed initiatives at the elementary levels). All 8th grade students will participate in a STEM job shadow day. Students in their high school years have access to educational options that integrate academic and technical skills and lead to postsecondary credentials with value in the marketplace. Students will have permeable pathways through postsecondary education, allowing them to transfer credit from one level to the next. There will be an expansion of teachers who are credentialed to teach college credit courses at the high school level. Online accredited courses for students are available for communities that don't have the teaching specialization. Students in a career pathway will have the opportunity to earn 12 or more dual credits in their chosen STEM pathway while in high school, at no cost to the student (see CTE-ECA Academies). The CCSNH will partner with area high schools and CTE-ECA's to provide dual credit opportunities. Dual admission exists between the CCSNH and the USNH so students can continue their education in NH.

	Students graduating from high school can go on to have a career in high-demand, high-wage STEM occupations that also provide the basis to pursue further education and career advancement. Employers in high growth STEM fields are able find the workforce they need to help grow their businesses. Employers in the high-growth STEM sectors within the state will commit to engaging with educators to build a sequence of work-based learning experiences for young people and to provide input and feedback on curricula and pathways development and improvement (refer recommendation that provides a platform for this to happen). There exists a common definition and measurement of college readiness so that students are aware of and encouraged to take the courses they need at the secondary level to be prepared for college level work. Students will be able to apply sophisticated theory and application to real-world problems, demonstrating the relevance of STEM and other academic disciplines (drawing on CCSS and NGSS). There will be a NH cross-sector (executive, legislative, and employer) state leadership team to guide and champion this work.
What is your recommendation/s (big idea/s) *Describe the recommendation. How does this recommendation achieve outcomes/goals to meet the needs of your target audience?*	**Pathways to and through STEM career paths exist for all students, from early middle school through high school years and beyond.** There will be **comprehensive systems** for (STEM) career information, advising, and exposure starting in middle school. **Individualized learning plans** (ILP's) are in place for students in grades 7 and 9. There will be a STEM Job Shadow Day for all 8th graders. **Students will have permeable pathways through postsecondary education**, allowing them to transfer credit from one level to the next. There is an **expansion of teachers who are credentialed** to teach college credit courses at the high school level. **Online accredited courses** for students are available for communities that don't have the teaching specialization. **Dual admission** exists between the CCSNH and the USNH. There will be **a common definition and measurement of college readiness** so that students are aware of and encouraged to take the courses they need at the secondary level to be prepared for college studies. Students in STEM career pathways will have the opportunity to earn **12 dual credits or more** in their chosen STEM pathway while in high school (at no cost to the student). **Employers** in the high-growth STEM sectors within the state **will commit to engaging with educators** to build a sequence of **work-based learning experiences** for young people and to provide input and feedback on curricula and pathways development and improvement.

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

	Employers in the high-growth STEM sectors within the state will commit to engaging with students, serving as **mentors and providing internships**.
Benchmarks and Timelines	Double the number of students entering STEM fields post-graduation by 2020 Increase the percentage of students graduating from New Hampshire high school with a STEM college and career ready diploma from xx% to 80% by 2020 Five years from the date of implementation, 80% of employers are able to find the talent they need in NH to fill their STEM related jobs including biotech, IT, advanced manufacturing and healthcare. The number of employers needed to meet the demand for helping to create curricula, providing mentorships and internships is met at the 100% target level at the time of implementation
Implementation plan: if this idea is implemented, what is needed to make it successful? *Who are the actors? What do they need to do?*	Financing at the federal (congressional appropriations) state and local level. Support from the Department of Education, Administrators, Educators, School Counselors, Employers and Parents
Challenges?	Business support, acceptance and funding of ILP's, time in the school day to cover career awareness, job shadow day, career counseling, etc. Time needed from educators and business people to created curriculum. Quality and quantity of internships and mentorships from the business community.
Resources needed?	Sustainable systems to support Individualized Learning Plans such as the Washington State model http://www.k12.wa.us/SecondaryEducation/careerCollegeReadiness/CareerReady.aspx or a system such as Naviance. More research needed as to best practices in guiding students in STEM career and college readiness. The Task Force will need to make a recommendation. Visionary educators and business professionals who can craft curriculum, create mentorships and internships and contextual learning environments. Human, financial, and capital resources from the national, state and business sectors.

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

Examples of best practices/similar approaches in current practice in NH or elsewhere?	• Pathways to Prosperity Report of June 2014 • Naviance system of guiding students  EDU-PLP_New_Jersey_DOE_Resource_Gu  Individualized Learning Plan (ILP) _  EDU-PLP_Providence _Program_Guide.pdf  VT. EDU-PLP_Critical_ Elements.pdf  naviance_white_paper_individual_learning • • Pathways in Technology Early College High School (P-TECH) in Brooklyn, New York, a collaboration between the New York City Department of Education, the City University of New York, New York City College of Technology and IBM. • In Utah, every middle school student takes a year-long, exploratory Career and Technical Education (CTE) Introduction course that provides students with direction, decision-making, and planning activities to explore career pathways. • The Maryland Governor's STEM Task Force and Maryland's College Success Task Force • Project Lead the Way**,** a program implemented in many schools for delivering STEM curriculum. • Washington State Model http://www.k12.wa.us/SecondaryEducation/careerCollegeReadiness/CareerReady.aspx UVBEP 8th grade job shadow day

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

ADDENDUM TWO (continued)

Group 7

DRAFT: MATHEMATICS CURRICULA PATHS (revised Sep 16, 2014)

Preamble:

With regard to mathematics education, the Governor's Executive Order 2014-01 empowered the Task Force to

A. Examine New Hampshire's current math standards and requirements;
B. Consider whether students should be offered multiple pathways for future careers, including increased applied math offerings;
C. Consider whether math requirements for high school graduation should be increased; and
D. Recommend any new math standards, requirements and offerings which the Task Force believes is necessary to ensure the competitiveness of New Hampshire's students and businesses in the future.

The State of New Hampshire Task Force on Mathematics Instruction issued a report in March 2012. The task force established two goals to guide its focus and efforts.

Goal #1: Provide recommendations that promote a K-12 continuum of mathematics curriculum and instruction that eliminates the need for mathematics remediation at post-secondary institutions.

Goal #2: Inspire educators in their task to design and implement authentic mathematical experiences and assessments so that students will effectively understand and apply their knowledge to new situations.

This report highlighted performance by New Hampshire students on assessment relating to NECAP and NAEP. The report also presented "Vision and Recommendations to Improve Student Achievement in Mathematics." The recommendations articulated by the task force are aligned to the Common Core State Standards. The report also focused on teacher preparation and professional development and recommended changes connected to teacher preparation programs, professional learning for practicing teachers, and curriculum and instruction changes at elementary, middle and high schools.

Against this backdrop, the Governor of NH recently signed HB 533 into law, and the bill establishes a 4-year high school mathematics requirement. *"A pupil may meet this requirement either by satisfactorily completing a minimum of 4 courses in mathematics or by satisfactorily completing a minimum of 3 mathematics courses and one non-mathematics content area course in which mathematics knowledge and skills are embedded and applied, as may be approved by the school board."*

This section of the Task Force report will address all four elements of the Governor's Executive Order.

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

A. Current Math Standards and Requirements:
B. Offer multiple pathways for future careers, including increasing applied math offerings.

Over the past decade a common and often self-fulfilling perception among high school and college students is that one cannot succeed in college calculus without having first done well in high school calculus. Many otherwise talented students give up on the prospect of a STEM career because they have not had access to a good calculus program in secondary school.

We recommend adopting the position taken by the National Council of Teachers of Mathematics and the Mathematical Association of America, "Although calculus can play an important role in secondary school, the ultimate goal of the K–12 mathematics curriculum should not be to get students into and through a course in calculus by twelfth grade but to have established the mathematical foundation that will enable students to pursue whatever course of study interests them when they get to college. The college curriculum should offer students an experience that is new and engaging, broadening their understanding of the world of mathematics while strengthening their mastery of tools that they will need if they choose to pursue a mathematically intensive discipline."

"What the members of the mathematical community— especially those in the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) — have known for a long time is that the pump that is pushing more students into more advanced mathematics ever earlier is not just ineffective: it is counter - productive. Too many students are moving too fast through preliminary courses so that they can get calculus onto their high school transcripts. The result is that even if they are able to pass high school calculus, they have established an inadequate foundation on which to build the mathematical knowledge required for a STEM career."

According to Lynn Steen, former president of the Mathematical Association of America (MAA), "It is probably about time that we face facts: Aiming school mathematics for calculus is not an effective strategy to achieve the goal of improving all students' mathematical competence." (*Mathematics Teacher* 100 [February 2006]).

The Curriculum Renewal Across the First Two Year (CRAFTY) report advocates secondary mathematics that facilitates students' transition from high school to college by providing (1) a greater emphasis on modeling; (2) consideration of multivariate topics; (3) an emphasis on computational skills that are useful in other fields; and (4) a strong foundation in units, scaling, and dimensional analysis. These recommendations were based on a thorough examination of the mathematical skills required in various disciplines such as biology, engineering, economics, physical sciences etc.

HB 533 creates the right impetus to provide alternative pathways for students to complete a minimum of 4 courses in mathematics and have a successful career in a STEM field.

Recommendation 1:

Provide multiple pathways with relevant and challenging mathematics content to complete the 4-course math requirement in high school. Each mathematics pathway includes rigorous, transferrable, college-level content that

meets the requirements of specific academic programs and careers. Currently, a student takes algebra I, algebra II, and perhaps pre-calculus. In college, this student may be put into intermediate algebra, followed by college algebra, and perhaps, yet again, pre-calculus, contributing to a high attrition rate. The advantage in offering multiple pathways is that students who choose a non-calculus pathway can still do engineering, and they can also think of careers in the health sciences, or business or the biological sciences. We recommend the following three pathways:

1. Students who enroll in a ***calculus pathway*** in secondary school should have demonstrated a thorough understanding of the concepts in algebra, geometry, trigonometry, and coordinate geometry. In addition, they can take courses in statistics or coding. Students who are skilled in algebra and analytical or coordinate geometry are much better prepared for calculus. The calculus course offered in secondary school should have the substance of a mainstream college-level course. Students interested in engineering or the physical sciences may wish to choose this pathway.
2. A second pathway should focus on the development of ***students' statistical thinking***. Statistics should include the field of data science including data visualization. Statistical thinking involves understanding the need for data, the importance of data production, the omnipresence of variability, and decision-making under uncertainty. Students interested in business, analytics or the biological sciences may wish to choose this pathway. However, students who choose this pathway and are interested in engineering or computer science in college can still do so and succeed.
3. A third pathway should include a solid grounding in ***linear algebra***. Linear algebra integrates algebra and geometry. This will serve them well in many areas in mathematics, computer science, engineering, and economics since they will be working with important multivariable problems.

   Please note that all pathways will and should include applications to move the discussion from abstract or general concepts to "applied" math. The examples should also include engineering in addition to the physical and biological sciences. Regardless of which pathway a student chooses, coding should be integrated into the math curriculum (see Recommendation 2 below). Furthermore, the ability to interpret data including data visualization should be emphasized in all the pathways.

C) Consider whether math requirements for high school graduation should be increased.

D) Recommend any new math standards, requirements and offering the Task Force believes is necessary to ensure the competitiveness of New Hampshire's students and businesses in the future.

HB 533 allows for one, non-mathematics content area course in which mathematics knowledge and skills are embedded and applied. In addition to integrating coding in the math curriculum, students could take courses in coding and programming, applied statistics, etc.

The group also suggests changing the language for the minimum standards requirements in mathematics for high school graduation as follows:

Current: Mathematics that encompasses algebra, mathematical modeling, statistics and probability, complex applications of measurement, applied geometry, graphical presentation and interpretation, statistics and data analysis – 3 credits.

Proposed: Multiple pathways in mathematics that encompasses algebra, mathematical modeling, statistics and probability, complex applications of measurement, applied geometry, graphical presentation and interpretation, coding and data analysis – 4 credits. While students will acquire some basic grounding in these topics, they will be able to specialize in a certain area of mathematics depending upon which pathway they choose.

Recommendation 2:

Integrate coding into the curricula:

Code (or coding) is the language of the future. Every app, every web page, every new piece of technology we use relies on programmers to help create it. When you help your students learn to code, you help them develop problem solving and logical thinking skills that they can use in jobs of the future. It is important for students to learn some of the key ideas of computer science, and to understand computational thinking. Coding will enable students to understand computational biology (how the genetic code works); algorithms, which essentially are mathematical instructions that make up programs; computer intelligence; recursion, in which solutions to smaller instances of a problem can be used to solve large problems. In addition to STEM and the humanities and the arts, students live in a world that is also shaped by networked computing.

The math classroom would be a perfect place to introduce coding concepts to students not enrolled in a traditional computer science course. Students who use programmable or graphing calculators to solve a quadratic equation are in essence doing coding. Other examples of coding include "using the logic of loops, if, else, do, and so on, to teach principles of proofs; concept of real numbers and integers, and how using the wrong data type affects coding; writing simple programs to solve a variety of applied math problems; graphing functions that serve as visual aids in understand important math concepts, etc. Coding should be about teaching logic and bigger concepts that learning a specific language. Thus learning experiences are critical. Math curricula should be grounded in mathematical questions that one may encounter in the STEM disciplines. A student can formulate the problem, ask the right questions and find relevant data to help solve the problem. The solution of the problem requires calculation and that is where coding is useful. In all instances, hand calculations are equally important; however, knowledge of coding will help students to solve complex applied math problems and also use data visualization to better understand the results. Unfortunately, if you cannot do coding, it will be hard to express yourself technically and therefore meaningfully. Coding therefore should be part of any math curriculum.

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

Teach an hour of code in elementary school. These could be simple computer science concepts without a computer. To build logic and analytical skills, coding can be introduced in both science and math. In middle school mathematics, abstract problems in algebra and/or geometry can be made more relevant through coding and computer science. Some of the modules can be aligned to the common core standards. In high school, core courses in Exploring Computer Science and Computer Science Principles will prepare students for post-secondary experiences.

According to the State of NH Task Force on Mathematics 2012 report, "the SMARTER Balanced Assessment Consortium for CCSS is committed to emphasizing the mathematical practices in its development of a summative assessment. Four claims have been articulated

Claim #1: Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.

Claim #2: Students can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.

Claim #3: Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.

Claim #4: Students can analyze complex, real-world scenarios and can construct and use mathematical models."

The introduction of multiple pathways and integration of coding in the math curriculum will go a long way in substantiating these "claims."

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH

ADDENDUM TWO (continued)

Group 6

DRAFT: TEACHER PREPARATION AND PROFESSIONAL DEVELOPMENT.REVISED 9.16.14

Recommendation: Ensure that all teachers have the knowledge, skills and pedagogy needed to help all New Hampshire students successfully complete a STEM-embedded curriculum.

The Governor's Executive Order 2014-01 empowered the Task Force to recommend changes to improve science, mathematics, technology and engineering (STEM) education in New Hampshire in order that students in kindergarten through 12th grade are prepared for and competitive in today's global, technology-driven society.

In order to achieve the curriculum outcomes of the accompanying Task Force recommendations[2], it is absolutely necessary to change the face of teacher preparation programs in New Hampshire universities. Likewise, the New Hampshire Department of Education and school administrators must support and provide meaningful and enduring professional learning opportunities for teachers already in our classrooms.

In The National Council on Teacher Quality's 2014 Teacher Prep Review, only Plymouth State University's elementary and secondary teacher education programs were notable. And while 107 programs in the nation were recognized for strong performance, not one in New Hampshire met that level of achievement. In 2013 the same review process revealed:

> The public higher education system has the primary responsibility for producing teachers for New Hampshire and must change its approach to better prepare candidates to meet new licensure requirements. Current data on preparation programs in New Hampshire indicate that they do not incorporate high value strategies for preparing STEM educators, do not produce the numbers of math and science teachers needed, and are not held accountable publicly for outcomes.

[2] See Recommendation 1 - C-Cubed, Recommendation 4 - Curriculum Integration, Recommendation 7 - Mathematics Curricula, Recommendation 8 - Next Generation Science Standards

> Together these reviews reveal that although New Hampshire has increased its requirements for teacher accountability, much improvement is needed in elementary teacher preparation and overall professional learning opportunities. "Preparation institutions must determine if the depth of math and science content in their programs is sufficient to support teacher candidates in achieving new licensure requirements, and if data-based decision making and inquiry-based instructional methods are appropriately incorporated into the candidate experience." [3]

The call for these two actions rests on the assertion that K-12 student interest and performance in mathematics and science is "solidly linked to teacher excellence." It follows that the generation of a mathematically and scientifically literate American workforce requires the development of a highly skilled workforce of teachers of mathematics and science.[2]

To address accountability for teachers already in the classroom, in 2012, NH Education Commissioner Virginia Barry effected a requirement that student performance be part of the State Teacher Evaluation Model by the 2014-2015 school year. This means educators need the promise of high quality, enduring opportunities to learn more than just content, but also improve the effectiveness of their craft. This may include opportunities during the school day for teachers to observe other teachers, provide feedback on mutually-developed lessons (Japanese Lesson-Study), get coaching on the use of technology and methodology, and receive ample time to reflect on the effectiveness new techniques. Simply put, teachers will need time to adjust their practices to new STEM curriculum demands and student needs.

With the adoption of the Common Core State Standards, and the recommended adoption of the Next Generation Science Standards, New Hampshire educators and educational leaders will need outreach and support to meet the rigorous demands of redesigning, rewriting, and re-benchmarking the new standards. Without central coordination and financing, initiatives will most likely not be executed in a timely, effective and efficient manner, risking delays, possible duplications of efforts statewide and cost-ineffectiveness. As noted in the New Hampshire Charitable Foundation's STEM Pipeline analysis, "having one organization responsible for this work and one person whose time is dedicated to this task makes all the difference in how fast a joint effort can move." (Education First, 2014)

[3] NH Charitable Foundation Report, Education First, NH STEM Pipeline 2013

Additionally, the New Hampshire State Task Force on Mathematics Instruction (2012) worked along this vein to address teacher preparation with several recommendations reflecting a belief that there needs to be a "System of professional learning and teacher preparation that reinforces the implementation of best practices in mathematics instruction." The collection of research that connects teacher knowledge of content and pedagogy is vast, and now is the time for these systems to be in place in order for our preservice teachers to *experience as students* the type of classroom climate that is expected of them *as teachers.* The following recommended actions are presented to meet that end:

Actions, Benchmarks, and Timelines

Revise and update New Hampshire teacher preparation programs to meet the demands of 21st Century Skills and pedagogy (2015)

- Increase content requirements in Elementary Teacher Prep programs, specifically in science content, inquiry process, and mathematics[4] (Immediately)
- Require Teacher Prep programs to publicly report measures of numbers of program graduates, job placement, and graduates remaining in the teaching profession (Immediately)
- Develop a rigorous interdisciplinary STEM teaching major/certificate program and/or utilize existing programs such as UTeach[5] to attract and retain quality, high-performing teacher candidates (2015)

Provide New Hampshire Educators with high quality, enduring, continuous Professional Learning Opportunities (2015)

- Employ Elementary Math Specialists in every district in NH[6](2016)
- Develop a STEM Specialist endorsement for elementary school teachers, which could be built upon the Elementary Math Specialist endorsement, and encourage employment in every district (2016)
- Develop a STEM endorsement for middle school teachers, perhaps including opportunities to teachers to earn micro-credentials in STEM areas, to show areas of expertise and build up to STEM endorsement (2016)
- Provide every teacher (PreK-12) plentiful opportunities for research-based, enduring professional development within their school day[7] such as mentoring, co-teaching, coaching, and full collaboration and

[4] NH State Task Force on Mathematics Instruction, Report to the State Board of Education 2012 - Recommendation #4, *Elementary and Middle School Mathematics*

[5] http://uteach-institute.org/

[6] NH State Task Force on Mathematics Instruction, Report to the State Board of Education 2012 - Recommendation #6, *Elementary and Middle School Mathematics*

[7] NH State Task Force on Mathematics Instruction, Report to the State Board of Education 2012 - Recommendation #3, *Teacher Preparation and Professional Learning*

engagement with lead teachers using effective, research based instructional models (i.e. Japanese Lesson Study, Instructional Coaching, etc)[8] (Immediately)

- [Utilizing STEM Centers for applications to real life Task Force, see Group 3 work](2016)
- Reward teachers who exhibit innovation, dedication, and commitment to the teaching of STEM subject[9] with badges or credentials warranting distinction in pay similar to that of "beyond Bachelor's" incentives for higher education (2015)
- Require school districts to offer teacher training on how to effectively utilize and incorporate 21st Century Skills in STEM instruction; and incentivize local businesses to provide summer research and other learning opportunities to teachers wishing to enhance their understanding of authentic contexts and real world applications (2015)

Appoint a STEM and NGSS Coordinator at the New Hampshire Department of Education

- Enlist the assistance of local Chambers of Commerce, Partners in Education, Teaching Associations and others to be determined to organize exemplary learning opportunities for teachers for hands-on, authentic learning
- Engage High School counselors as champions of STEM pathways; steering students toward development of 21st Century Skills in areas of science, technology, engineering, and mathematics
- Develop a plan to disseminate the NGSS
- Plan and organize high quality, enduring, continuous learning opportunities for teachers, highlighting those with research-based techniques and real-world contexts

[8] NH State Task Force on Mathematics Instruction, Report to the State Board of Education 2012 - Recommendation #1, *Teacher Preparation and Professional Learning*

[9] Adapted from NH State Task Force on Mathematics Instruction, Report to the State Board of Education 2012 - Recommendation #4, *Teacher Preparation and Professional Learning*

Governor's Task Force on Science, Technology, Engineering and Math Education (STEM)

September 16, 2014

Manchester Community College, Manchester, NH